

Granary Environmental Monitoring System Using ZigBee and ARM Processor

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Abstract - The Grain storage is the important factor for seasonal production. Grain is an important strategic resource of the country. This article designs Granary environment storage monitoring system which is having combination of Embedded system and ZigBee Wireless Sensor Network technology. The design of wireless sensor network using ZigBee which is used for multipoint acquisition and transmission of environment parameters using ARM7 to the Grain storage manager which improves the Scalability and flexibility of grain storage management.

Keywords - Granary Monitoring, Zigbee ,Arm Processor.

1. Introduction

Grain is our country's important strategic resources. The seasonal production of the grain it is very difficult to maintain the grain quality level for a long time. Due to different environment conditions and the variation in the environment parameters in grain storage depot the quality level decreases also there is a loss of grain also. So the cost of labor increases. So the storage of grain in the proper environment should be our top priority event. Because it effects people's livelihood. The automatic monitoring of the grain storage will help us to improve the operation levels of grain storage, reduce the grain losses during stored procedure and reduce labor intensity. This article designs Granary environment storage monitoring system which is having combination of Embedded system and ZigBee Wireless Sensor Network technology. The design of wireless sensor network using ZigBee which is used for multipoint acquisition and transmission of environment parameters using ARM9 to the Grain storage manager which improves the Scalability and flexibility of grain storage management. Using the powerful data collection capabilities of embedded

microcontroller to process all kinds of data, which sends available data to grain depot manager in time and filters invalid data on the spot. Which saves a lot of manpower and material resources and improves labor productivity.

2. The Overall System Plan

The system is mainly made up of the main ARM7 controller unit, wireless monitoring and control unit. Parts of the wireless monitoring and control unit using star network mainly include sensor node (or control node) and the coordinator nodes. The sensor node (or control node) is the key part of the wireless monitoring unit and control unit, and also is the focus of this paper. This node is mainly responsible for the collection and transmission of the environment information (such as temperature, humidity, light etc.).The signals collected by the sensor through the A/D conversion are sent to the MCU processing. The ZigBee communication module changes the data into the data packets of ZigBee communication protocol which are transmitted to the coordinator node. After the coordinator node receiving the data packets sent by the sensor node (or control node), on the one hand, it would start handshake communication, i.e., it sends a confirmation language source to the node of sending data according to the original path in order to complete a full ZigBee wireless communication process; On the other hand, it should upload the data to the ARM master unit through the serial port. The ARM master unit gathered the collected information data, So environment of grain storage is achieved intelligent control. The ARM master accesses network and provides network services by connecting GPRS modules. Storage managers can focus the storage information received through system. and send control instructions to the grain storage depot to

maintain the necessary environmental conditions. When any abnormal situations appear, then system can send a timely parameters to the storage manager also if parameters crosses its limit then an alarm signal will be generated. The embedded database solite transplanted in the ARM master, and it can move the collected data and the directives which are issued by the ARM master into the database for querying by users.

3. System Hardware Design

The hardware of the system is mainly composed of the ARM7 processor based on LPC2114 and wireless transceiver transmission network based on CC2430.

(A) Processor is designed to provide hand-held devices and general applications with low-power, and high-performance microcontroller solution in small die size. To reduce total system cost, the LPC2114 minimizes overall system costs and eliminates the need to configure additional components.

Features of ARM7 TDMI-S(LPC2114)

- Integrated system for hand-held devices and General embedded applications.
- 8kB to 40 KB onchip static RAM
- USB 2.0 full speed compliant
- Two 32-bit timer/ external event counter
- 16/32-Bit RISC architecture and powerful. Instruction set with ARM7 CPU core.
- Enhanced ARM architecture MMU to support WinCE, EPOC 32 and Linux operating system.
- Instruction cache, data cache, write buffer and Physical address TAG RAM to reduce the effect of main memory bandwidth and latency on Performance.
- ARM7 CPU core supports the ARM debug Architecture.
- Internal Advanced Microcontroller Bus Architecture(AMBA) (AMBA2.0)

(B) The design of terminal nodes ZigBee is the latest proposed, two-way wireless communication technology which is close, low complexity, low power, low data rate, low-cost. ZigBee uses self-organization network. The architecture is known as wireless infrastructure wireless local area network. This architecture has no restriction on the number of devices within the network, and can always create a wireless communications link .In the system designed in this paper, the terminal node uses CC2430 chip as the processor nodes. CC2430 integrates industry-leading 2.4GHz IEEE802.15.4 (ZigBee RF transceiver CC2420) and the enhanced 8051MCU (typical

performance up to 8 times the performance of the standard 8051) and superior performance, which has ultra-low power, high sensitivity and superior interference. CC2430 ZigBee protocol stack built, coupled with low consumption and other characteristics, makes it possible use low cost components ZigBee nodes, and highly competitive. CC2430 includes a DMA controller, 8K bytes of static RAM, 4K bytes of which is ultra-low power SRAM, 32K, 64K or 128K bytes of on-chip Flash block to provide in-circuit programmable nonvolatile memory. In view of the designed system is applied to the grain storage warehouse and transfer the environmental parameters to the destination. The parameter such as: temperature, humidity, light. In addition to similar 18B20 (temperature sensor) digital sensor ports directly connected with the

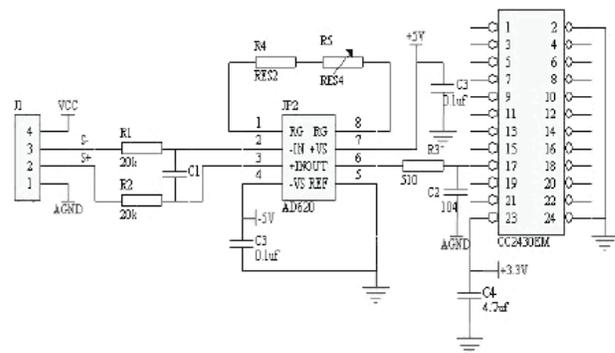


Fig. 1 Schematic of sensor node.

CC2430, its sensor end-nodes of the circuit has been shown in Figure 1. As shown above, the AD620AN (Analog Devices company's instrumentation amplifier) has been selected as the signal conditioning circuit. The Transistor in the input of AD620AN integrated circuits provides differential bipolar input to ensure the accuracy of demand in gain control. The structure of three op-amp instrumentation amplifier has been used in it, the resistance of external resistor Rg determines the actual magnification of AD620. (Where R1, R2 is the current limit resistor, used to protect the input stage)

4. System Software Design

4.1 Software Design of ZigBee Wireless Sensor Network

The achieved network topologies of ZigBee wireless sensors are star, mesh and cluster-like networks. The system of this paper uses star network topology. Star network topology consists of a network coordinator and a

number of network terminals. Among them, the network coordinator is the core of the network. Its main role is to create networks and the configurations relating to network, such as helping to establish the security layer of the network and process the binding of application layer and so on.

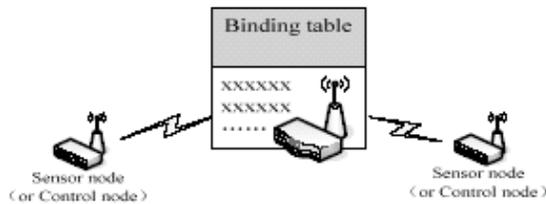


Fig. 2. Indirect binding between the endpoint.

In this design, it must establish a binding table entry at the end of the coordinator before any two nodes to communicate. The role of coordinator is to maintain the binding table and forward packets. Figure 2 is the form of indirect binding instructions of end points. In this design, use of indirect binding to establish a binding table. When there are data communication requests in the two bound sensor nodes, the coordinator will forward automatically basing on the binding table. If the bound nodes are not in the network, the coordinator will write data to the temporary buffer. After the binding nodes add to it, it would forward.

If the buffer is full ,the oldest data packets are automatically discarded. Based on the analysis of above tasks, following three tasks is to complete the system: Tasks Main, ZigBee to Com, Com to ZigBee. Tasks Main will realize the protocol stack initialization, network connection maintenance ,task initialization and call. Com to ZigBee will package the data that is send from the serial port through ZigBee protocol then sent to the ZigBee wireless network. ZigBee to Com's mission is to send the data that transfer from ZigBee network to the serial port through the ZigBee protocol resolution, hand in the ARM host controller. The process shown in Figure 4:Coordination module not only complete the tasks of networking but also realize bi-directional data transfer between serial and ZigBee network protocol, On the one hand,it transfers the data sent from serial into the data that can be sent to network by ZigBee protocol. On the other hand, it transfers the data that send from ZigBee network into the data that can be transported in serial port by ZigBee protocol, in order to realize the communication of the ARM main controller.

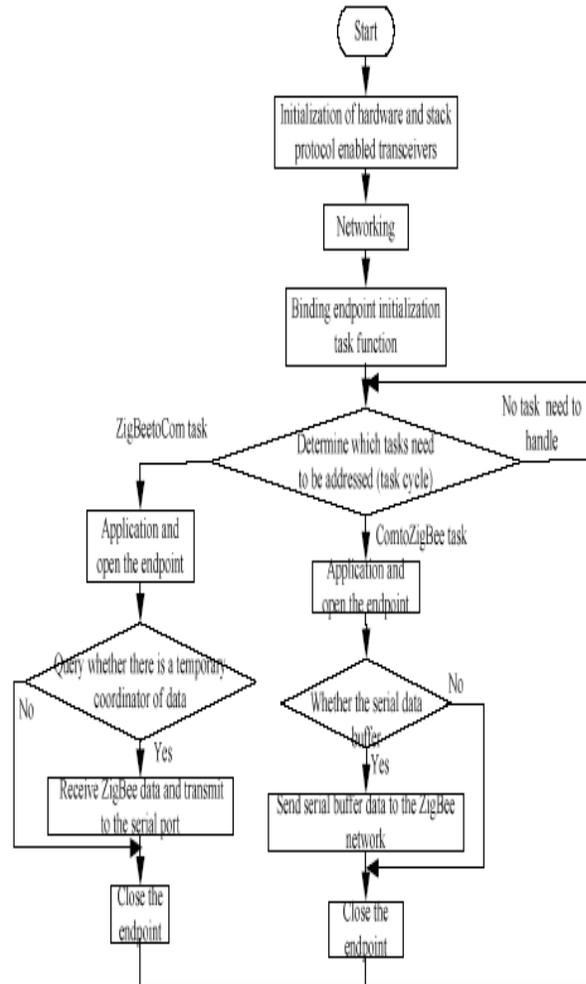


Fig. 3 Part of the program flow chart of ZigBee Network Coordinator.

The software process designation of Sensor nodes (or control node) is less complex than that without coordination, the main tasks that it contains are the node access to the network, collection of the environmental information data and data transmission (Control node instead of the part of data collection in sensor will complete the collection of the device).

4.2 Software Design of ARM Host Controller

The overall software structure of the ARM main controller is shown in Figure 3. The system adopts Linux as the operating system of the ARM's main controller. The work needed to be done is: the cutting and transplantation of Linux2.6.32, the programming of the serial driver, the programming of touch screen driver and the migration of SQLite database, the system also adopts the graphical user interface based on QT/E and

establishes a QT user interface to optimize the human-computer interaction environment Linux Operating System Figure 4. The overall structure of system software of ARM data control module Remote communication module is mainly made of two parts the wireless communication modules and the serial port module. Using SQLite databases to the collecting storage information in the system is to provide the theoretical basis of managing storage environment to the user. The database has a series of advantages: powerful, simple interface, fast, small size and so on,so it especially uses in the embedded systems. In this system, the version of the database is SQLite-3.5.9. At the mode the command line, creating house database in the/root/Family Gate catalog and inserting the data table collective table (used to store the collection of environmental information data) and action table (recording movement data of the system).

5. Transmitter Section

In transmitter section the module successfully transfers the Environmental parameters (i.e. Temperature, Humidity, Light) to Receiver Section by using ZigBee. In this section all the sensors successfully gathering the analog values from grain storage atmosphere and transferring these values to ARM processor. After converting analog to digital ARM transfers these values to ZigBee (XBEE2- 4214A).Where ZigBee is transferring atmospheric parameters serially to Receiver end.



Fig. 4 Receiver Section

In Receiver section the module successfully receives the Environmental parameters (i.e. Temperature, Humidity, Light) in digital from transmitter Section by using ZigBee. These values are received by RxD pin of microcontroller 8051 serially. 8051 successfully transferring these values to LCD display as well as COM Port of PC. Where Hyper Terminal receives the serial data and display it on the monitor for future reference we can save the data available on Hyper Terminal. The screen

shot shows the received data on LCD. Also it successfully generate alarm (buzzer tone) if any parameter exceeds the threshold limit.



Fig. 5 Welcome Screen



Fig. 6 Receiver Section

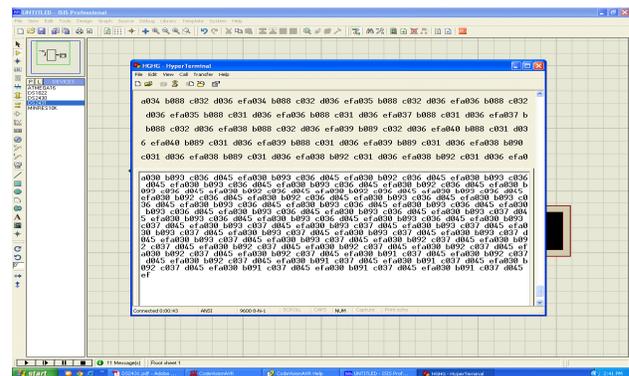


Fig. 7 Output on HyperTerminal

Hyper terminal receiving the serial data on COM Port and display on the terminal Where 'a' representing the temperature in degree Celsius, 'b' is for Humidity in percentage, 'c' is for Light in Lux (Ev).

6. Conclusion

The Granary Environment Monitoring system is developed based on the integrating with ARM control

technology, ZigBee wireless communication and sensor technology. By using this system we can intelligently monitor the different environmental parameters remotely. Which provide greater scalability with superior performance. This system provides real time information on the secured network of ZigBee. it can guarantee the data collected transmitted to the user management center real-time, to ensure that the user can barn environment timely and make the right decisions. This system reduces the energy consumption significantly, but also reduces a large number of inputting on the human and material resources in the management. The system designed is very simple, it enhances the system's flexibility, low cost, small in size and easy to use, also it is easy to install and migrate.

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